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(57) Abstract

A generally cylindrical tube (20) for the transport of flowable materials comprises a strip (22) arranged in a plurality of wraps about an axis, at least a portion of the tube (20) having a spring modulus biasing the tube (20) into an axiallly extended position. Each wrap is canted so that successive wraps have overlapping opposite edge portions (24). The tube (20) is at least partially compressible in an axial direction from its axially extended position while maintaining a generally cylindrical shape. The tube (20) is manufactured in a thermal forming jig (30) where a generally flat strip of material (22) is wrapped by a free form process into a tube (20) having a plurality of overlapping wraps. The jig includes a guide for receiving the strip (22) from a path and an open longitudinal slot (96) arranged at an angle to the path for guiding the strip (22) to wrap the strip (22) so that successive strips (22) have overlapping opposite edge portions (24). A package system comprises a container (70, 88, 94) for flowable materials containing a self extending tube (20), for example a drinking straw. The tube (20) is at least partially axially compressed and placed within the container (70, 88, 94) so that a free end of the tube (20) bears against the closure (80, 90, 98). Upon removal of the closure (80, 90, 98) from the container (70, 88, 94), the tube (20) extends to its axially extended position through the outlet (82, 92, 102).

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PACKAGE SYSTEM FOR FLUIDS AND MANUFACTURE THEREOF

BACKGROUND OF THE INVENTION

This invention relates to package systems for flowable materials, and particularly to containers with tubes, such as drinking straws and the like, for drawing fluid therefrom.

Beverages, such as soft drinks, are commonly marketed in bottles, cans, and boxes of individual serving sizes. While the internal portions of the container, including the beverages contained therein, remain hygienically clean, the external surfaces are exposed to environments which are not necessarily clean. Since consumers often consume the beverages directly from the bottle or can with direct contact to the external surfaces, the consumer is often exposed to an unacceptable level of filth on the bottle or can. In the case of box containers, drinking straws are often hygienically attached to an external surface of the box for insertion into the box by the consumer. However, the external surface of the box is often contaminated, resulting in a contamination of the straw upon insertion. Further, the box package is more expensive to manufacture, primarily due to the additional shrink wrapping of the straw to the external portions of the box.

Various attempts have been made to incorporate drinking straws in beverage containers. Some of these attempts have incorporated straws having compressed bellows portions which axially unfold to extend through the outlet of the container. Other attempts employed coiled straws which uncoiled. However, such straws did not exhibit good spring action and consequently failed to reliably extend after a period of time. Other attempts employed telescoping straw parts relying on a spring or buoyant structure to extend the straw, but these also proved unreliable as well as costly. Yet other attempts employed straws fastened to the closure or cap so that

the straw is pulled up through the outlet with the removal of the closure. This latter group has proven both costly and unreliable because the user removed the straw with the cap. Consequently, there is a need for an economical packaging system for packaging fluids in which a straw or draw tube is retained in the package in a hygienically sound fashion and is reliably operated to extend through the outlet upon removal of the container closure.

SUMMARY OF THE INVENTION

The present invention is directed to a package system in which a container containing fluids also contains a self extending draw tube, for example a drinking straw. The tube is axially compressed and bears against the closure of the container at the outlet. When the closure is removed, the tube axially extends through the outlet or fluid port for use by the consumer.

More particularly, the tube comprises a strip arranged in a plurality of wraps about an axis, the strip having a spring modulus biasing the tube into an axially extended position with successive wraps overlapping at opposite edge portions. The tube is at least partially axially compressed and positioned within the container so that a free end of the tube bears against the closure. Upon removal of the closure from the container, the tube extends to its axially extended position through the outlet.

One aspect of the present invention resides in the provision of a thermal forming jig for wrapping a generally flat strip of material into a tube having a plurality of overlapping wraps. The jig includes a guide for receiving the strip from a path and a longitudinal slot arranged at an angle to the path for guiding the strip to wrap the strip so that successive wraps have overlapping opposite edge portions.

Another aspect of the present invention resides in the process of forming a tube with a plastic strip with successive wraps having overlapping opposite edge portions so that the strip has a spring modulus biasing the tube into an axially extended position.

Yet another aspect of the present invention relates to the provision of a drawing tube or drinking straw that includes a compressible portion and a non-compressible portion. More particularly, the compressible portion is formed from a strip arranged in a plurality of wraps about an axis and exhibits a spring modulus. The non-compressible portion can comprise a tube portion also formed from a plurality of wraps which are locked in their extended position, or can comprise a continuous walled tube portion which is connected with the compressible portion. Such tubes including both a compressible and non-compressible portion advantageously permit the designing of such a tube for a specific purpose whereby the axial length of the compressible portion determines in part the spring modulus of the resultant whole tube and limits the amount of expansion thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 are perspective views of a draw tube or drinking straw for use in a package system in accordance with the presently preferred embodiment of the present invention, the tube being in an axially extended position in Figure 1 and in a partially axially compressed position in Figure 2.

Figure 3 is a perspective schematic view of apparatus for manufacturing the tube illustrated in Figures 1 and 2.

Figures 4 and 5 are perspective and end views, respectively, of a thermal forming jig for use in the apparatus of Figure 3.

Figure 6 is a perspective view of the thermal forming jig illustrated in Figures 4 and 5 illustrating the process of manufacturing the tube illustrated in Figures 1 and 2.

Figures 7 and 8 are top views of the thermal forming jig illustrated in Figures 4-6 illustrating different aspects of the process for manufacturing the tube illustrated in Figures 1 and 2.

Figure 9 is a perspective view of a package system in accordance with one embodiment of the present invention comprising a bottle and cap having an axially compressed drinking straw as illustrated in Figure 2.

Figure 10 is a perspective view of the apparatus illustrated in Figure 9 with the cap removed and the drinking straw axially extended through the outlet.

Figure 11 is a perspective view of a package system in accordance with another embodiment of the present invention comprising a can and tape closure with an axially compressible drinking straw as illustrated in Figures 1 and 2.

Figure 12 is an enlarged section view of the outlet portion of the package system illustrated in Figure 11.

Figure 13 is a perspective view of a package system in accordance with another embodiment of the present invention comprising a box and tape closure with an axially compressible drinking straw as illustrated in Figures 1 and 2.

Figure 14 is a section view of the straw and sleeve illustrated in Figure 13.

Figure 15 is a perspective view of a modified draw tube or drinking straw in an axially extended position with an overwrap of successive wraps thereof fixed together at a point along the length of the tube.

Figure 16 is a perspective view of another modified draw tube or drinking straw similar to Figure 15 with an overwrap of successive wraps thereof fixed together at a

point along the length of the tube by an alternate method.

Figure 17 is a perspective view of yet another modified draw tube or drinking straw which is a hybrid tube including an axially collapsible portion comprising overwraps and a non-collapsible portion comprising a continuous walled tube.

Figure 18 is a cross-sectional view of yet another modified draw tube or drinking straw within a beverage container, the tube having an overwrap of successive wraps fixed together at a point along the length thereof by a collar, the collar further including elements for positioning the draw tube or straw within a beverage container.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figures 1 and 2 illustrate a draw tube or drinking straw 20 for use in a package system in accordance with the present invention. Tube 20 comprises an extended strip 22 of plastic film. The strip is wrapped to form successive echelons or wraps whose upper edge portions overlap the lower edge portion of the adjacent echelon or wrap to form overlaps 24. As an example, tube 20 may be formed of a strip of biaxially-oriented polyester film having a width of about 0.625 inches and a thickness of about 0.004 inches, wrapped to an external diameter of about 0.25 inches. The resulting tube has a spring modulus which biases it into its axially extended position illustrated in Figure 1, and which can be axially compressed as illustrated in Figure 2. Other materials useful for fabrication of tubes 20 include biaxially-oriented or unoriented polypropylene, cast polycarbonate and cast cellulose ester, to mention a few. The width and thickness of the material will depend on the rigidity of the material and the purpose to which the resulting tubes will be placed.

Tube 20 is manufactured by a thermal forming process to alter the alignment of the molecules in the crystalline structure of the strip. More particularly, biaxially-oriented materials such as biaxially-oriented polyester exhibit a "memory" by which the shape of a biaxially-oriented article may be distorted under mechanical force or pressure, and the article will return to its undistorted shape upon relaxing the mechanical force or pressure. Such materials exhibit a spring modulus to return to the undistorted shape. The "memory" of such materials may be changed in a thermal forming process by which the material is subjected to mechanical force or pressure to form an article of desired shape, heated to the thermal forming temperature of the material, and then cooled while in the desired shape. As used herein "thermal forming temperature" means the temperature, below the glass transition temperature, at which the molecular alignment in the material may be altered while maintaining the crystalline structure, thereby inducing an altered shape and memory. The thermal forming process alters the memory of the material to remember the desired shape so that if the article is thereafter distorted from the desired shape created in the thermal forming process, the article will return to that desired shape when the distortion forces are removed.

Figures 3-8 illustrate the apparatus for thermal forming tube 20. As illustrated in Figure 3, reel 26 contains an extended length of biaxially-oriented polyester strip material 22, which is dispensed through transport mechanism 28 to thermal forming jig 30. Drive roller 32, operated by motor 34, drives strip 22 into jig 30 where strip 22 is wrapped into a cylindrical, tubular shape with successive echelons or wraps overlapping at overlaps 24 (Fig. 1). The wrapping occurs in an open jig so that the strip reacts against an internal surface of the jig without the aid of a mandrel or the like to form

the tube. Overlaps 24 bear against each other in an interference fit to form a fluid-tight seal to permit transport of fluids in the resulting tube. The tube thus formed is heated to its thermal forming temperature thereby altering the memory of the material to remember the extended cylindrical shape of the tube. The memory function of the polyester strip assures that tube 20 will return to its axially extended position after compression. Tube 20 is then passed through air cooler 36, guillotine apparatus 38, and over collection box 40 until an end of the tube reaches sensor 42.

As shown particularly in Figure 3 and 6, tube 20 is extruded from thermal forming jig 30 as a continuous tube. When an end of tube 20 reaches sensor 42, a signal is provided to guillotine 38 to cut or slice the tube, permitting the cut portion to fall into collection box. The lengths of successive individual tubes 20 is controlled by the distance between guillotine 38 and sensor 42.

Heaters 44 and 46 are positioned within thermal forming jig 30 and are controlled by power control 48 to heat jig 30 to the thermal forming temperature of strip 22. Preferably, a thermal sensor, such as a thermocouple 54 (Figure 6), is mounted to jig 30 and is connected via electrical wire 49 to power supply 48 to allow for control of the temperature of the thermal forming jig.

Jig 30 is illustrated in greater detail in Figures 4 - 6 and includes a heat conducting block 50, for example constructed of copper, having bores 52 and 53 for receiving heaters 44 and 46 (Fig. 3) and a bore receiving a thermocouple sensor 54. Longitudinal slot 56 has an internal arcuate surface 58 (Fig. 5) against which the strip reacts to form the cylindrical shape to the tube without the strip being wrapped onto any internal support, such as a mandrel or the like. Hence, heat transfer to strip 22 in jig 50 is accomplished only at surface 58 of slot 56. Slot 56 has a longitudinal

opening to guide surface 57 slightly above the bottom of arcuate surface 58. The arrangement of arcuate surface 58 and the opening to guide surface 57 is such that the arc formed by surface 58 is between about 180° and 270° around the axis of rotation of the arc. Most preferably, the arc formed by surface 58 is of the order of about 250°. At least the discharge end 60 of surface 58 has a frustoconical shape to facilitate exit of cylindrical tube 20. Hence, the diameter of slot 56 is slightly greater at discharge end 60, than at end 62. The jig is preferably arranged to produce tubes having small diameters, namely diameters of about 0.25 inches outside diameter, or less. To manufacture cylindrical drinking straws having an outside diameter of about 0.25 inches, the diameter of slot 56 is about 0.25 inches at its narrow end 62 and about 0.26 inches at end 60.

The tube formed of wrapped plastic strip material according to the present invention is nominally cylindrical, as opposed to conical. Each wrap is slightly canted due to the overlapping of the edges of successive wraps, but the outside diameter of each wrap is defined by the same portion of the internal arcuate surface of jig 50. Hence, the tube is substantially cylindrical rather than conical, and has a constant nominal diameter as formed in jig 50.

As shown particularly in Figures 7 and 8, slot 56 is positioned at an angle to the path of strip 22, the path being defined by transport 28 (Figure 3). A comparison of the overlap portions 24 of the finished tube in Figures 6 and 7 illustrate that the amount of overlap of successive wraps increases with the incident angle 65 of the path to the axis of slot 56. For a drinking straw having a nominal diameter of about 0.25 inches, manufactured of a strip having a width of 0.625 inches, an angle of about 32° provides an overlap of about 0.15 inches at each overlap 24. This overlap forms an interference fit between opposite edge portions of

successive wraps to form a fluid seal between the overlaps for a non-leaking cylindrical drinking straw when the straw is in its axially extended position.

A polyethylene terephthalate (PET) strip 22 having a width of 0.625 inches and a thickness of 0.004 inches was fed into jig 50 at an angle of 32°. The strip was fed into the jig at various feed rates identified in Table I and the temperatures required to reach thermal forming were recorded. As shown in Table I, optimum feed rates are obtained with a jig temperature of about 210 C° at a feed rate of about 500 centimeters per minute.

TABLE I
Temperature vs. feed rate
to thermal forming
for 4 mil PET

Temperature C°	Feed Rate cm/min
200	315
205	220
210	500
215	420
225	280
230	245
235	220

Another example of suitable material for draw tubes according to the present invention is unoriented 0.008 inch thick polyethylene napthalate (PEN). In this case the jig is heated to about 115 C° and the strip of material is fed at a rate of about 200 cm/min to achieve thermal forming of the material.

The completed tube 20 is discharged from end 60 along the axis of slot 56. The completed tube is then cooled in cooler 36 and cut to desired length by guillotine 38, as herein described.

Following completion of tube 20 by the apparatus illustrated in Figure 3, the memory characteristics of the tube may optionally be enhanced by an annealing process whereby the tube is subjected to an elevated temperature for a predetermined time. More particularly, the extended tubes 20 are heated in an oven to a

temperature well below the thermal forming temperature of the material for a time between about 8 and 72 hours. The temperature used is below the thermal forming temperature so as not to change the shape of the tube. In the case of tubes constructed of biaxially-oriented polyester, the annealing temperature is between about 70°C and 90°C, with satisfactory results occurring at a temperature of about 80°C after about 12 hours. Annealed tubes have displayed better spring recovery characteristics than non-annealed tubes, particularly over extended periods (six months or more) of distortion or compression, and particularly in warm liquids such as soup or coffee.

Figures 9-14 illustrate packaging systems in accordance with various embodiments of the present invention. Figures 9 and 10 illustrate a disposable polyester bottle 70 having a neck 72 formed in the upper portion thereof and feet 74 in the lower portion thereof, with substantially cylindrical sidewall 76. Threads 78 are formed in neck 72 to receive a disposable threaded cap 80 to close fluid port or outlet 82 at the neck. Tube 20 is disposed unsupported within the container 70 so that a free end nests in one of the foot portions 74. When cap 80 is attached to the threaded portion of the bottle, tube 20 is axially compressed by the cap. Thus, as shown in Figure 9, draw tube or drinking straw 20 is axially compressed into the bottle so that the tube bears against the bottom of the bottle and against cap 80 at outlet 82 (Figure 10). The neck of bottle 70 guides the free end of tube 20 into reaction against cap 80. Upon removal of cap 80, as illustrated in Figure 10, the "memory" of tube 20 allows the free end of the tube to axially extend through outlet 82 for use by the consumer.

Figures 11 and 12 illustrate the use of tube 20 in a can 88 in which the free upper end of tube 20 nests within ring guide 84 formed in the top 86 of the can container. A removable adhesive strip 90 is arranged to

close the outlet port 92 formed in the top 86 to seal outlet 92. Drinking straw 20 is compressed within the can to nest within ring 84 and bear against closure strip 90. When strip 90 is removed or pulled away, as illustrated in Figure 11, the free end of the drinking straw extends through outlet 92 to its axially extended position for use by the consumer.

Figures 13 and 14 illustrate a beverage container comprising box 94. Compressible drinking straw or tube 20 is nested in internal sleeve 96 to bear against removable strip 98 attached to the top 100 of box 94. Conveniently, sleeve 96 is formed by folding an extension of the box material and attaching it to the inside of box 94 while the same is being manufactured. When strip 98 is pulled away or removed, the free end of tube 20 extends through fluid port or outlet 102 to its axially extended position for use by the consumer.

Fluid port or outlet 82, 92 and 102 is larger than the outside diameter of tube 20, thereby permitting the tube to easily extend through the outlet without restriction or binding on the outlet walls, and establishing atmospheric pressure inside the container for proper operation as a straw.

Referring now to Figures 15 - 18, plural embodiments of a modified draw tube or drinking straw are illustrated, each embodiment having in common that the draw tube or drinking straw comprises both a collapsible portion and a substantially non-collapsible portion. Moreover, the compressible portion of each embodiment comprises a plurality of wraps of an extended strip of material formed into a tube in accordance with that of the Figures 1-14 embodiment described above.

As shown in Figure 15, a tube 200 is illustrated which is divided into a collapsible portion 202 and a substantially non-collapsible portion 204 by a weld 206. The weld 206, as illustrated, is provided along one of the overwraps 208. The weld 206 may extend only a

portion of the way around the longitudinal axis of the tube 200 or more. It is only necessary that any two successive wraps be fixed together at a point thereof. The point of fixing constituting that which divides the tube 200 into the collapsible portion 202 and the non-collapsible portion 204.

By fixing a pair of successive wraps at the overlap 208 thereof with weld 206, portion 204 of the tube 200 is rendered substantially non-collapsible. This happens as a result of the tube 200 being made in the same manner as that described above with regard to the tube 20 illustrated in Figures 1-14. More specifically, starting from end 210 of the tube 200, each successive wrap is wrapped to be on the outside of the lower edge of the previous wrap. In other words, each overwrap 208 comprises a portion of a successive wrap which lies over a portion of each preceding wrap. Then, by fixing one overwrap 208 between any two successive wraps, the wraps provided from that point toward end 210 are rendered substantially non-collapsible. A slight amount of compression may occur as the overwraps 208 are forced more tightly together; however, fixing the one overwrap 208, such as at weld 206, substantially prevents axially movement of the wraps at the overwraps 208.

With regard to the wraps below the fixing point, which in this embodiment comprises the weld 206, these wraps within collapsible portion 202 remain unaffected. More specifically, the overwraps 208 of portion 202 are free to permit axial sliding between successive wraps as the portion 202 is compressed.

The result is a tube 200 with the non-collapsible portion 204 thereof being substantially fixed in length and the collapsible portion 202 thereof being collapsible depending on the material from which the tube 200 is made and the dimensions thereof. Potentially, the portion 202 is collapsible to the width of the strip 22 of plastic material from which tube 200 is made.

By axially fixing a portion of the tube 200, the amount of collapsing and thus extension is limited. Moreover, the spring modulus of the entire length of the tube 200 is reduced in that only a portion of such length is expandable from its collapsed state to its "memory" condition. Furthermore, since it is only necessary that the tube 200 extends from a beverage container of the like by a relatively small amount for use by a consumer, the amount of expansion is easily accommodated by a relatively short collapsible portion 202. The tube 200 is preferably provided in combination with a beverage container so that the substantially non-collapsible portion 204 thereof extends through the opening of the container and is the portion which directly interfaces with the consumer and which advantageously has a more rigid feel. The collapsible portion 202, as discussed above, provides an effective transfer tube since the overwraps thereof form a fluid seal.

Referring now to Figure 16, a tube 220 is illustrated which is similar to tube 200, described above, and includes a collapsible portion 222 and a substantially non-collapsible portion 224. The tube 222 is fixed at a point along it axial length by a piece of tape 226 which divides the tube 220 into the collapsible portion 222 and substantially non-collapsible portion 224. Again, at least a portion of an overwrap 228 is fixed by the piece of tape 226. The effect of the piece of tape 226 is the same as that of the weld 206 of the Figure 15 embodiment described above, and the non-collapsible portion 222 and the substantially non-collapsible portion 224 of the tube 220 react in the same manner.

It is further contemplated that any other known or subsequently discovered manner of fixing an overwrap of successive wraps can be used in accordance with the present invention. Specifically, an overwrap can be fixed with adhesives, by fusing the material of the

successive wraps together at the overwrap, by mechanically connecting the overwrap, or otherwise. Examples of fusing techniques include heat welding or ultrasonic welding. Suitable adhesives can be any adhesives including hot melt adhesives which are compatible with the materials comprising the tubes or drinking straws and the environment within which the tube or drinking straw is to be used.

Referring now to Figure 17, yet another modified draw tube or drinking straw 230 is illustrated which comprises, like the Figures 15 and 16 embodiments, a collapsible portion 232 and a substantially non-collapsible portion 234. More specifically, the tube 230 is a hybrid tube in that the collapsible portion 232 thereof is made in accordance with the tubes of the previous embodiments comprising successive wraps, and the non-collapsible portion 234 comprises a continuous walled tube in the same sense as a conventional drinking straw. The non-collapsible portion 234 is fixed with the collapsible portion 232 by any conventional fixing means such as a weld shown at 236. In the same sense as the manner of fixing an overwrap in the Figures 15 and 16 embodiments, the portions 232 and 234 can be fixed together by adhesives, fusing, taping, mechanically connecting, or otherwise taking into consideration the materials used and the environment of use. Preferably, as also illustrated in Figure 17, the non-collapsible portion 234 also includes a conventional bending mechanism 238 which permits bending of an upper portion 235 of the non-collapsible portion 234 for consumer convenience. The axial length of the collapsible portion 232 is determined based on the amount of extension that the non-collapsible portion 234 is to extend from a beverage container or the like. Again, overlaps 233 of the collapsible portion 232 insure a substantial fluid seal between the successive wraps.

Yet another draw tube or drinking straw 240 is illustrated in Figure 18 provided within a beverage container comprising can 242. The tube 240 is made in accordance with the method discussed above with reference to the Figure 1 embodiment, and is divided into a collapsible portion 244 and a substantially non-collapsible portion 246 by a collar 248. The collar 248 is fixed at a point along the axial length of the tube 240 so as to fix at least a portion of an overwrap 250 provided between successive wraps which make up the tube 240. The collar 248 can be fixed to a successive overwraps by any of the conventional means discussed above including adhesive, fusing, mechanically connecting, or otherwise. The collar 248 as fixed with the tube 240 functions similarly as the tape 226 of the Figure 16 embodiment to divide the tube 240 into the collapsible portion 244 and the substantially non-collapsible portion 246.

An additional feature which can be provided with the collar 248 is the provision of a plurality of positioning elements 252 which extend radially from the collar 248 to a contact the internal surface 243 of the can 242. Three of such positioning elements 252 are illustrated with the understanding that more or less can be provided depending on the specific application. Moreover, it is contemplated that positioning elements 252 can be provided at different axial locations along the axial length of the collar 248 so as to further hold the tube 240 at a specific location within any such beverage container such as can 242. Alternatively, the bottom 257 of the can 242 can be provided with an indent at 254 for locating the bottom of the tube 240 which together with the positioning elements 252 hold the tube 240 in position below the opening 256 of the can 242. It is understood that the same concepts can be applied to beverage containers of almost any shape with openings at various locations.

It is further understood that the collar 248 and positioning elements 252 can be made by any conventional technique including fabricating the collar and positioning elements separately and adhering, fusing or mechanically connecting the elements together, by injection molding, or by an extrusion process. In any case, the collar and positioning elements can be specifically designed to be insertable with the tube 240 into the container through an opening, such as opening 256. To do this, the positioning elements 252 must be sufficiently resilient so that they can be folded along side the tube 240 for insertion through the opening 256 followed by the radial extension of the positioning elements 252 within the can 242. Again, the use of resilient positioning elements can be applied to any number of container designs.

The present invention thus provides a package system for fluids in which a drinking straw or other draw tube is axially compressed within the closed container so that upon removal of the closure from the outlet, the tube automatically axially elongates so that a free end of the tube extends through the outlet for access by the consumer. The packaging system provides an economic hygienic beverage container, or the like, which is easy to use by the consumer. The tube has demonstrated satisfactory results with a wide variety of beverages including carbonated beverages, wine, wine coolers, beer, milk, juice and juice concentrates as well as more viscous materials such as custards, milk shakes, yogurt and puddings, as well as liquids having solid materials in suspension therein, such as pulps associated with citrus drinks. The tube has worked well with cool fluids, such as chilled drinks at temperatures of about 5°C, as well as hot drinks such as coffee at temperatures of up to about 70°C. The overlapping wraps to the tube provide a good fluid seal under normal conditions of a drinking straw when the tube is axially extended.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A package for flowable material comprising:

a container for storing flowable material, the container having an outlet through which flowable material may be removed;

a closure for attaching to the container to close the outlet; and

a tube comprising a strip arranged in a plurality of wraps about an axis, at least a portion of the tube having a spring modulus biasing the strip into an axially extended position with successive wraps having overlapping opposite edge portions, the tube being so disposed and arranged within the container that when the closure is attached to the container the tube is at least partially compressed in an axial direction from its axially extended position and a free end of the tube bears against the closure and that when the closure is removed from the container the tube extends to its axially extended position through the outlet.

2. A package as in claim 1 further including retention means in the container for retaining the free end of the tube in the region of the outlet.

3. A package as in claim 2 wherein the container is a bottle and the retention means comprises a neck of the bottle.

4. A package as in claim 2 wherein the retention means is a ring extending into the container surrounding the outlet.

5. A package as in claim 2 wherein the retention means is a sleeve within the container receiving at least

a portion of the tube so that the free end of the tube bears against the closure at the outlet.

6. A package as in claim 1 wherein the successive wraps of the strip overlap in an interference fit when the strip is in its axially extended position.

7. A tube for use in a container containing flowable material, the container having an outlet through which flowable material may be removed and a removable closure attached to the container for closing the outlet, said tube comprising a strip arranged in a plurality of wraps about an axis, at least a portion of the tube having a spring modulus biasing the strip into an axially extended position with successive wraps having overlapping opposite edge portions, the tube being so disposed and arranged as to be at least partially compressed in an axial direction from its axially extended position with a free end of the tube bearing against the closure when the tube is in the container with the closure closing the outlet, whereby when the closure is removed from the container the tube extends to its axially extended position through the outlet.

8. A package as in claim 7 wherein the successive wraps of the strip overlap in an interference fit when the strip is in its axially extended position.

9. A package as in claim 7 wherein the tube is cylindrical.

10. A generally cylindrical tube for transporting flowable material comprising a strip arranged in a plurality of successive wraps about an axis, at least a portion of the tube having a spring modulus biasing the strip into an axially extended position, each wrap being canted so that successive wraps have overlapping opposite

edge portions, the tube being at least partially collapsible in an axial direction from its axially extended position while maintaining a generally cylindrical shape.

11. A tube as in claim 10 wherein the successive wraps of the strip overlap in an interference fit when the strip is in its axially extended position.

12. A forming jig for wrapping a generally flat strip into a tube having a plurality of overlapping wraps, said jig having a guide for receiving a portion of a surface of the strip from a path and an open longitudinal slot for receiving the strip portion from the guide, the slot having an axially aligned arcuate internal surface for guiding a surface of the strip to wrap the strip, the axis of the slot being arranged at an angle to the path so that successive wraps have overlapping opposite edge portions, thereby forming an axially extended tube.

13. A forming jig as in claim 12 further including heating means for heating the jig to at least the thermal forming temperature of the strip so that heat is transferred to the strip entirely by the arcuate internal surface.

14. A forming jig as in claim 13 comprising a heating block having the longitudinal slot and guide formed therein, the heating block being formed of thermally conductive material, the heater means being mounted to the block.

15. A forming jig as in claim 12 wherein at least a portion of the arcuate internal surface is a frustoconical surface open at its base end to form an exit through which the tube may be removed from the jig.

16. A forming jig as in claim 12 wherein the arcuate internal surface extends greater than 180° about the axis.

17. A process for forming an axially-compressible tube comprising:

continuously feeding a generally flat strip into a longitudinal slot having an axially-aligned arcuate internal surface, the strip being fed at an angle to the axis of the slot to form a continuous tube having a plurality of wraps of material with successive wraps having overlapping edge portions;

heating the arcuate internal surface to the thermal forming temperature of the tube so that heat is transferred entirely from the arcuate internal surface to the tube; and

cooling the tube.

18. The process as in claim 17 wherein at least a portion of the arcuate internal surface is a frustoconical surface open at its base end, the process further including removing the tube through the base end.

19. The process as in claim 17 wherein the material is biaxially-oriented polyethylene terephthalate, the temperature is in the range between about 200°C and 235°C and the strip is fed into the jig at a feed rate between about 220 and 500 cm/min.

20. The process as in claim 17 wherein the material is unoriented polyethylene napthalate, the temperature is about 115°C and the strip is fed into the jig at a feed rate of about 200 cm/min.

21. The process as in claim 17 further including annealing the tube at a temperature of between 70°C and 90°C for a time period between 8 and 72 hours.

22. A process for forming an axially-compressible tube comprising:

continuously wrapping a generally flat strip of plastic material to form a small diameter tube having a plurality of wraps of material with successive wraps having overlapping edge portions;

heating the tube to the thermal forming temperature of the material; and

cooling the tube.

23. The process as in claim 22 further including annealing the tube at a temperature of between 70°C and 90°C for a time period between 8 and 72 hours.

24. The process as in claim 22 wherein the material is biaxially-oriented polyethylene terephthalate, the temperature is in the range between about 200°C and 235°C and the rate of feeding the strip is between about 220 and 500 cm/min.

25. The process as in claim 22 wherein the material is unoriented polyethylene napthalate, the temperature is about 115°C and the rate of feeding the strip is about 200 cm/min.

26. A tube for transporting flowable material comprising a collapsible portion and a substantially non-collapsible portion, said collapsible portion comprising a strip arranged in a plurality of wraps about an axis of the tube and having a spring modulus biasing the strip into an axially extended position with successive wraps having overlapping and contacting opposite edge portions.

27. The tube of claim 26, wherein said substantially non-collapsible portion comprises a strip arranged in a plurality of wraps about said axis of the tube with successive wraps having overlapping and contacting opposite edge portions, and at least one overwrap of successive wraps comprising overlapping and contacting opposite edge portions is fixed to restrict axial collapsing of said substantially non-collapsible portion.

28. The tube of claim 27, wherein said strip arranged to form said non-collapsible portion is the same as said strip arranged to form said collapsible portion.

29. The tube of claim 28, wherein said at least one overwrap of successive wraps is fixed by a weld.

30. The tube of claim 28, wherein said at least one overwrap of successive wraps is fixed by an adhesive.

31. The tube of claim 28, wherein said at least one overwrap of successive wraps is fixed by a piece of adhesive tape.

32. The tube of claim 28, wherein said at least one overwrap of successive wraps is fixed by a collar that is fixed with said tube.

33. The tube of claim 32, wherein said collar further includes a plurality of positioning elements extending radially from said collar for positioning within a container and engagement with an inner surface of the container.

34. The tube of claim 33, wherein said positioning elements are resilient so that they can be folded

alongside said tube for insertion of the tube and collar within the container.

35. The tube of claim 26, wherein said substantially non-collapsible portion comprises a continuous walled tube, and said continuous walled tube is fixed with said collapsible portion at an end thereof.

36. The tube of claim 35, wherein said substantially non-collapsible portion further includes a bending mechanism for permitting bending of at least a portion thereof from the axis of said tube.

37. A package for flowable material comprising:

a container for storing flowable material, the container having an outlet through which flowable material may be removed;

a closure for attaching to the container to close the outlet; and

a tube for transporting flowable material comprising a collapsible portion and a substantially non-collapsible portion, said collapsible portion comprising a strip arranged in a plurality of wraps about an axis of the tube and having a spring modulus biasing the strip into an axially extended position with successive wraps having overlapping and contacting opposite edge portions.

38. The package of claim 37, wherein said substantially non-collapsible portion comprises a strip arranged in a plurality of wraps about said axis of the tube with successive wraps having overlapping and contacting opposite edge portions, and at least one overwrap of successive wraps comprising overlapping and contacting opposite edge portions is fixed to restrict

axial collapsing of said substantially non-collapsible portion.

39. The package of claim 38, wherein said strip arranged to form said non-collapsible portion is the same as said strip arranged to form said collapsible portion.

40. The package of claim 39, wherein said at least one overwrap of successive wraps is fixed by one of a weld, adhesive, and a piece of adhesive tape.

41. The package of claim 39, wherein said at least one overwrap of successive wraps is fixed by a collar that is fixed with said tube.

42. The package of claim 41, wherein said collar further includes a plurality of resilient positioning elements extending radially from said collar for positioning within a container and engagement with an inner surface of the container, said resilient positioning elements being foldable alongside said tube for insertion of the tube and collar within the container.

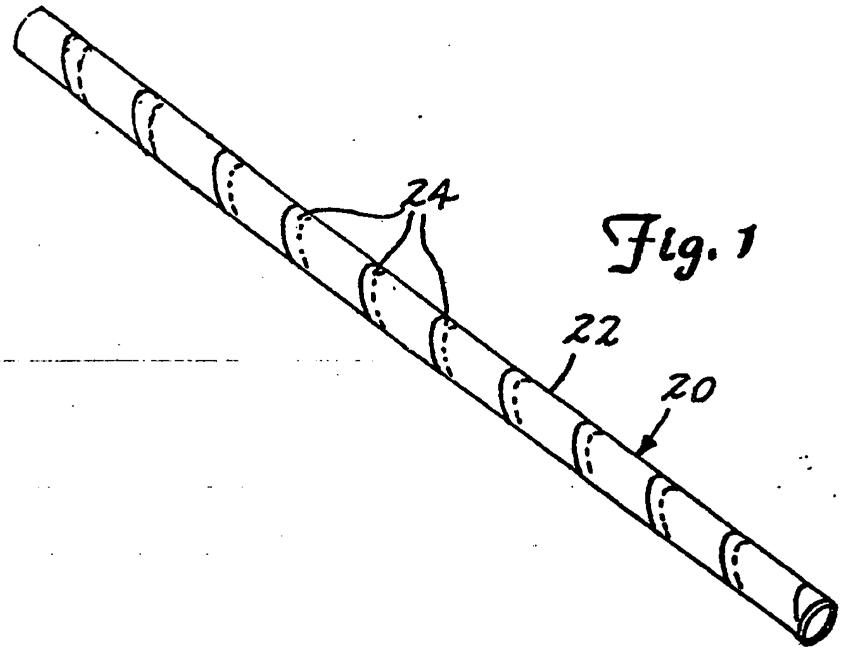


Fig. 1

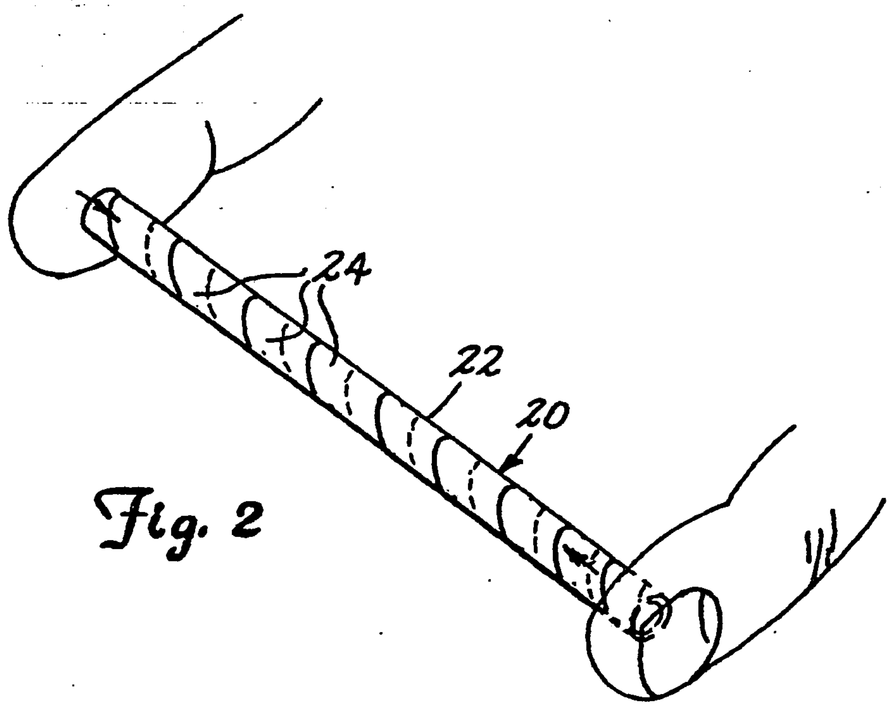


Fig. 2

Fig. 3

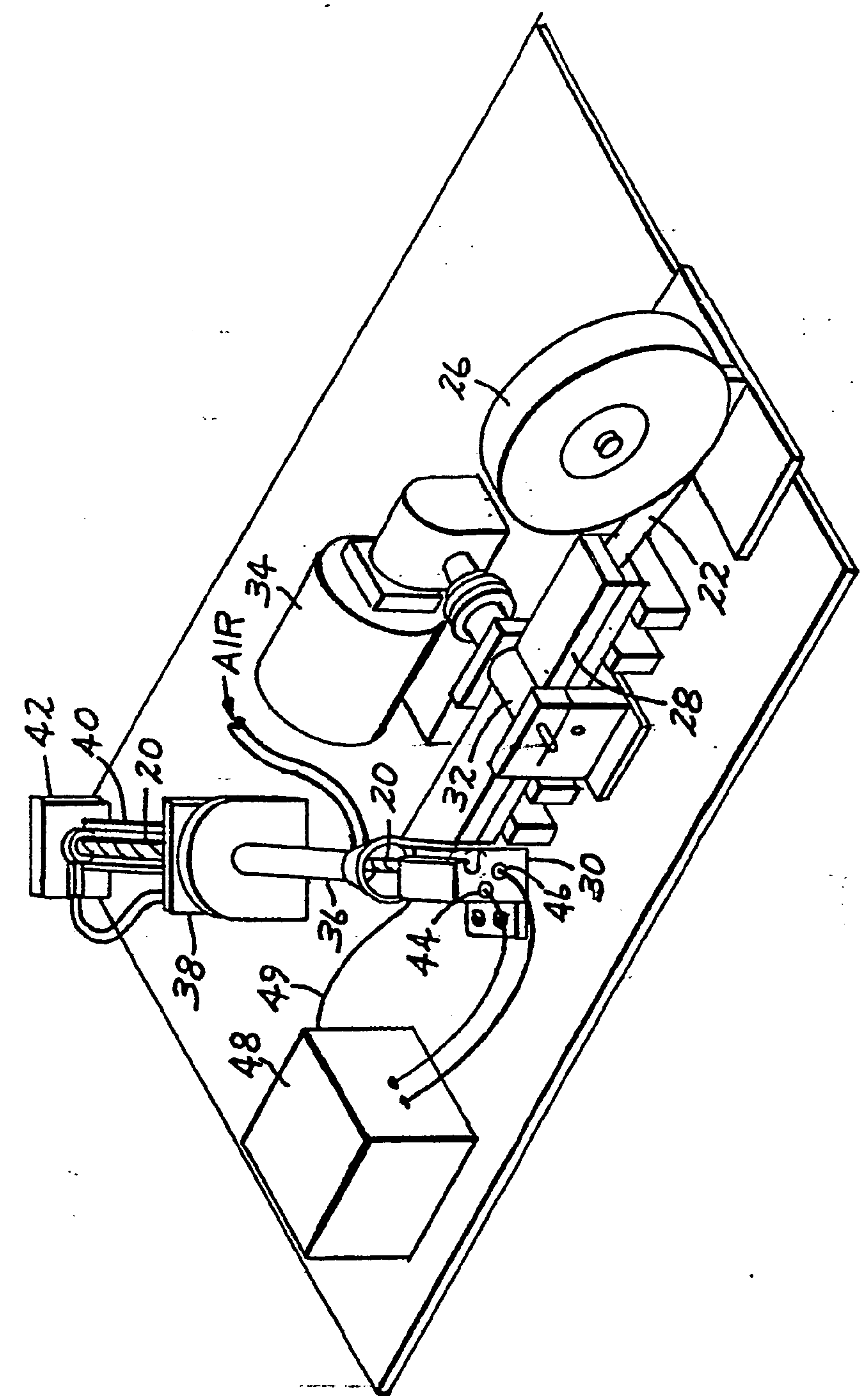
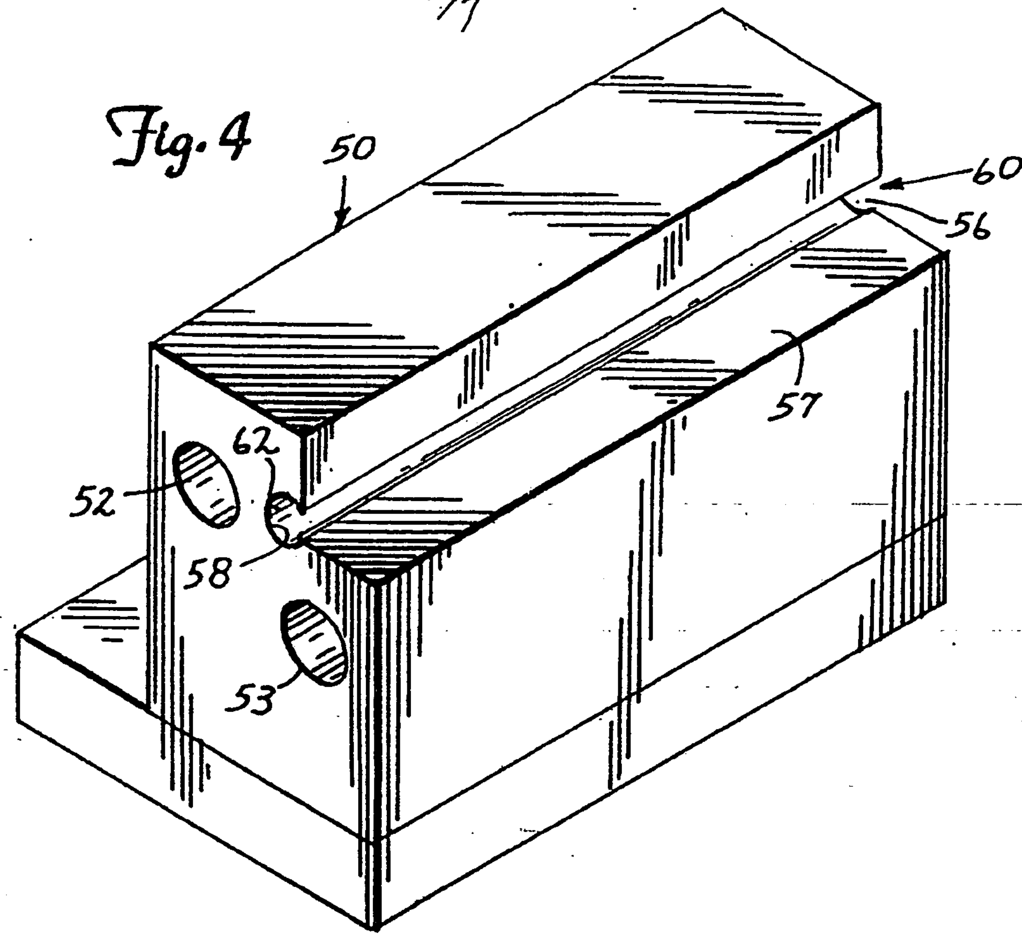


Fig. 4



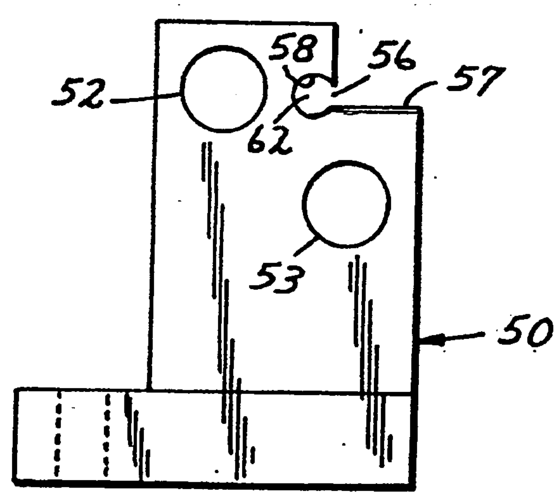


Fig. 5

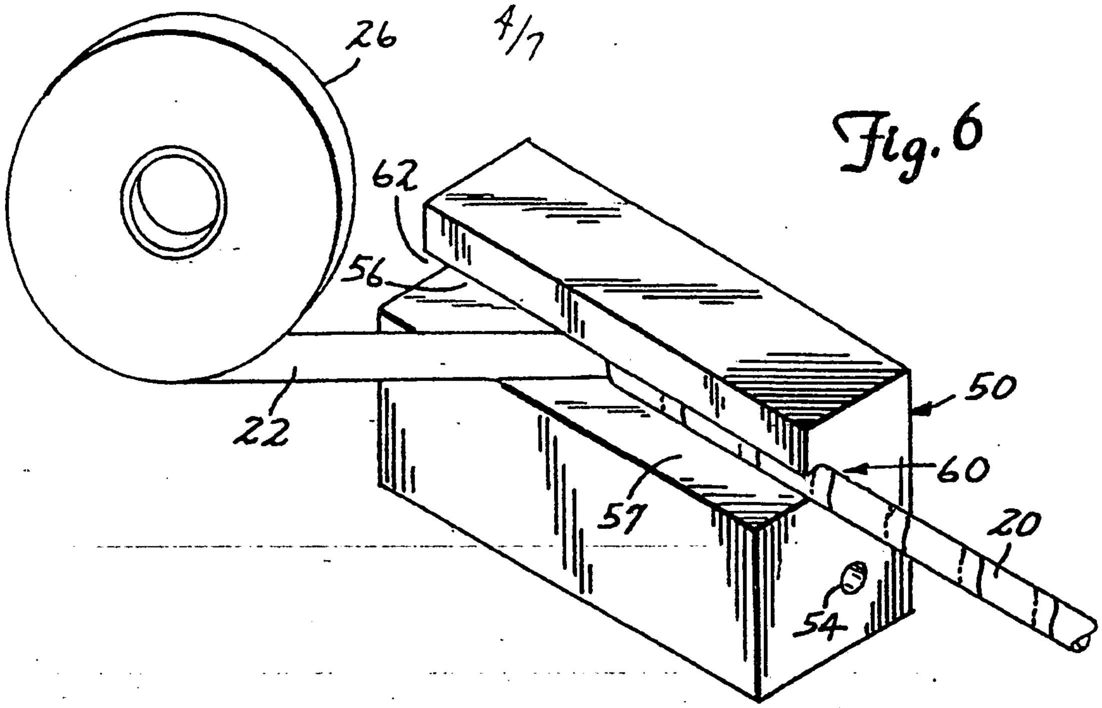


Fig. 6

Fig. 7

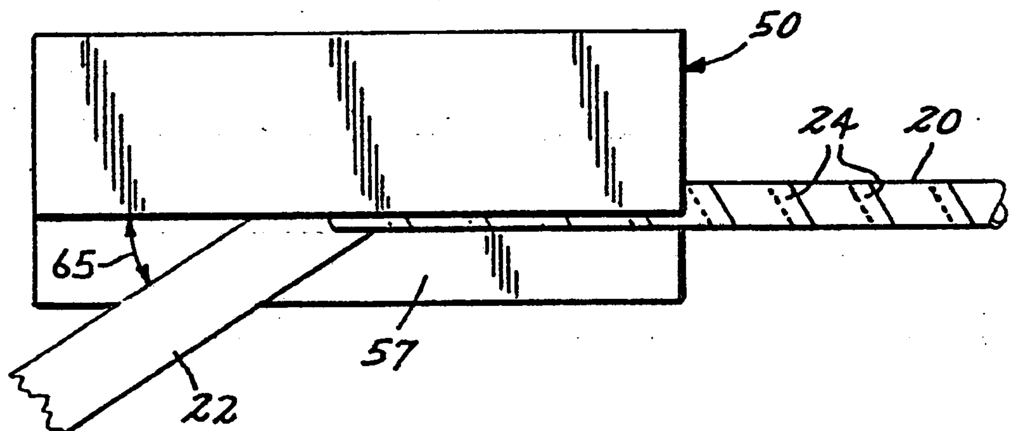


Fig. 8

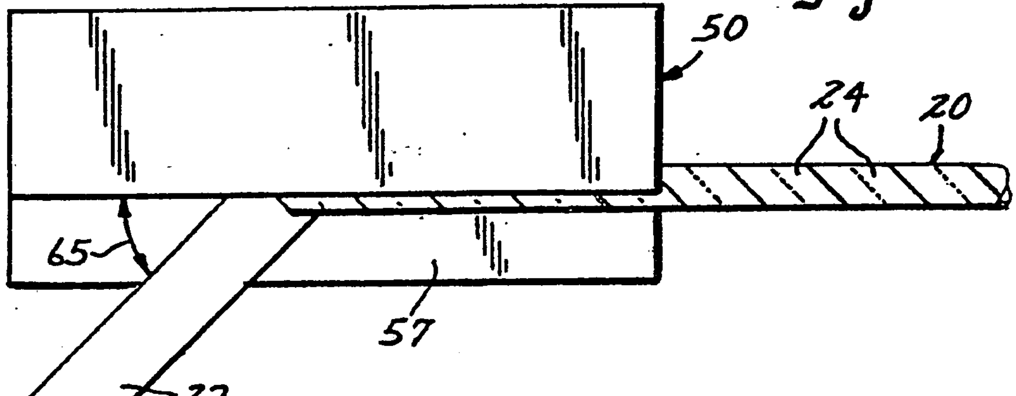


Fig.10

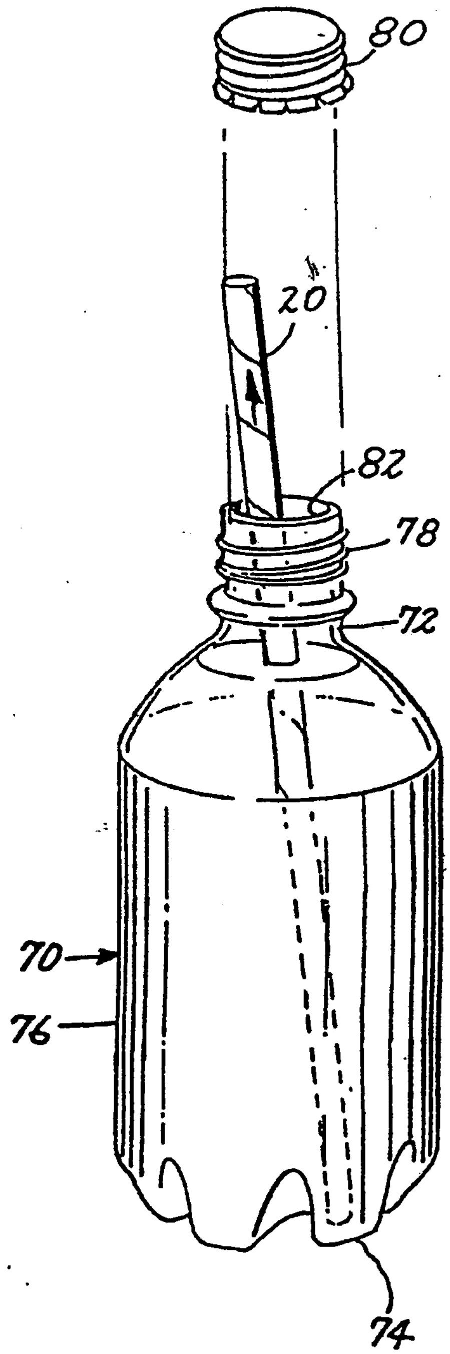


Fig.9

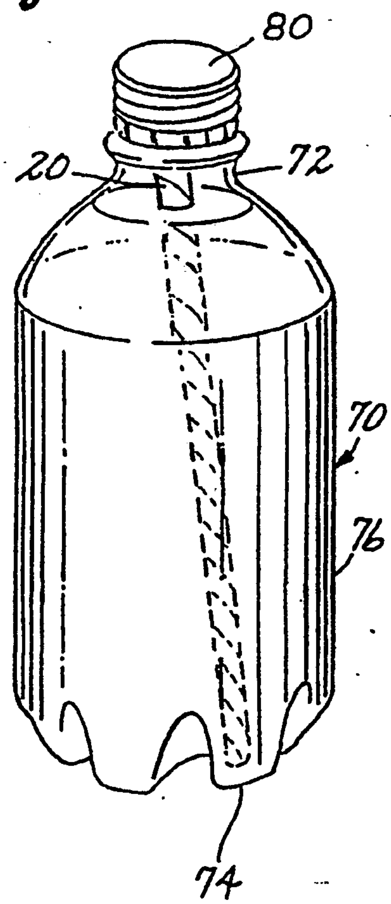
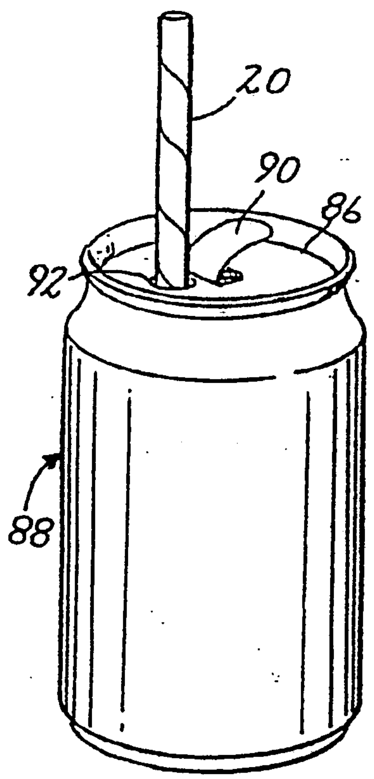


Fig. 11



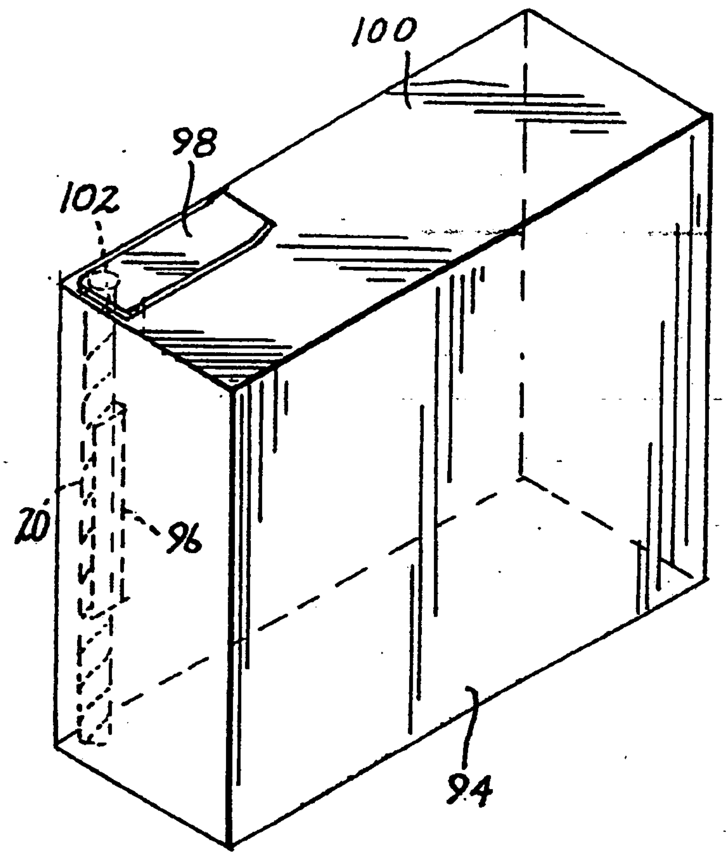
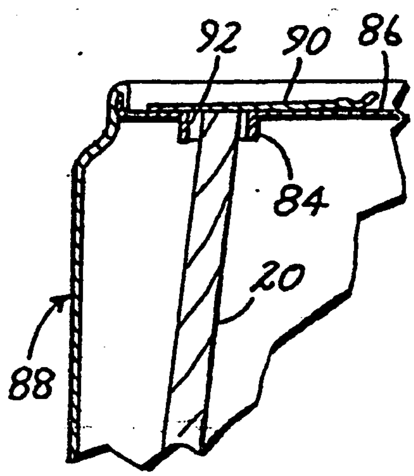


Fig. 13

Fig. 12



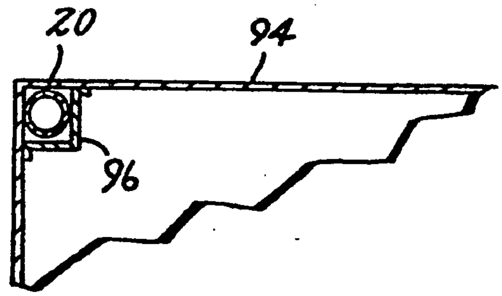


Fig. 14

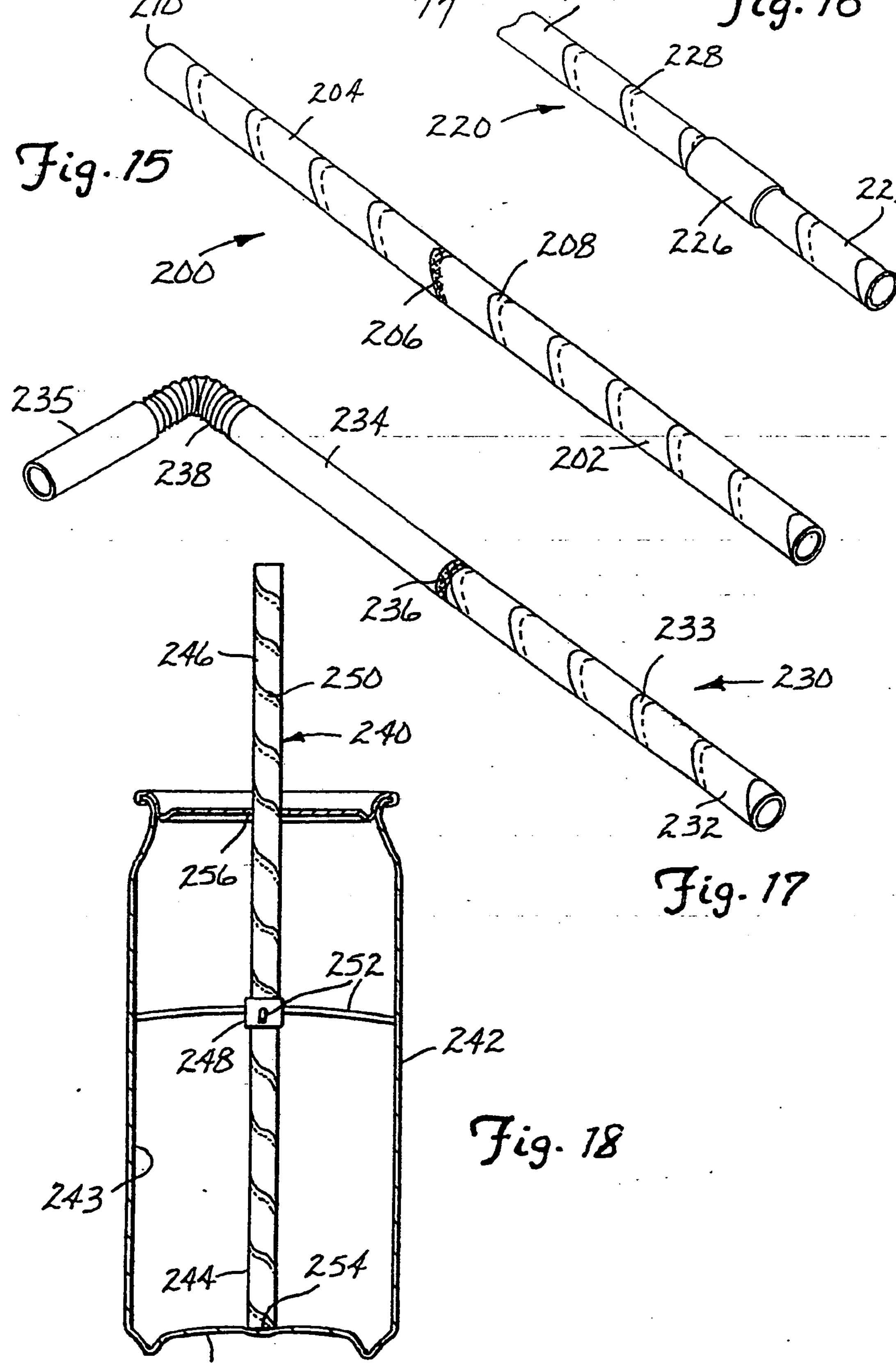


Fig. 15
Fig. 16
Fig. 17
Fig. 18